IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Art Unit: 1793	
Examiner: Roe, Jessee Randall	Title:
In re application of	Eglin Steel – A Low Alloy High Strength Composition
M. Dilmore et al.	
Serial No. 10/761,472	
Filed: January 21, 2004	Attorney Docket 040650

DECLARATION OF JOHN PAULES
UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, John R. Paules, depose and say as follows:

1. I am employed as General Manager of Ellwood Materials Technologies, a subsidiary of Ellwood Group, Inc., the parent of Ellwood National Forge, Co., the present owner of the patent application referenced above (the "Subject Application").

2. I earned B.S. and M.Eng. degrees in Metallurgy and Materials Science from Lehigh University in 1976 and 1981, respectively, and have worked in the field of steel metallurgy for 30 years. I am a registered Professional Engineer in the Commonwealth of Pennsylvania. I have worked with Ellwood Materials Technologies since 1997 with various steel alloy development programs, including the development and testing of Eglin Steel, the low alloy steel described in the captioned patent application ("Subject Application"). In particular, I am responsible for development of melting, forging, and heat treatment practices which result in mechanical properties and service performance which meet requirements for Eglin Steel. I have directed research

studies of the fine scale microstructure of Eglin Steel to gain a full understanding of the effect of fine precipitate particles on properties such as strength and toughness. I have published and presented a technical paper on the development and properties of Eglin Steel.

3. The specification of the Subject Application lists five sets of mechanical properties (*See* Table 3) for the alloy composition range recited in the claims of the Subject Application for five different sample heats, *i.e.*, ES-1 through ES-5. The specification of the Subject Application did not provide chemical compositions for each heat, but provided a "typical chemistry" to obtain properties found in Table 3 (*See* paragraph 0019 and Table 2). Based on information and belief after reviewing records acquired from investigators who performed the actual experiments, including one of the named inventors of the Subject Application, James Ruhlman, the following Table contains the measured actual compositions of the five heats of Eglin Steel in the Subject Application listed as ES-1 through ES-5 in Table 3 of the Subject Application.

Composition of Five Sample Heats of Eglin Steel in Subject Application										
	C	S	Mn	Si	Cr	Ni	Mo	Cu	V	W
ES-1	0.24	0.0007	0.53	1.05	2.59	1.01	**0.42**	0.006	**0.085**	**0.99**
ES-2	0.26	0.0007	**0.06**	**0.02**	2.97	1.03	-	0.008	0.28	2.93
ES-3	**0.22**	0.0007	0.50	**0.17**	2.96	1.02	-	0.008	0.26	2.94
ES-4	0.26	0.0006	0.50	**0.17**	2.96	1.01	-	0.008	0.26	2.94
ES-5	0.28	0.0006	0.50	1.00	2.96	1.00	-	0.008	0.27	2.98

4. On information and belief, the U.S. Patent Office issued an Office Action dated June 23, 2008, rejecting the claims of the Subject Application based primarily on the information disclosed in the following patent ("Beguinot"):
U.S. Patent No. 5,695,576 to Beguinot.

5. I have reviewed the Subject Application, the June 23, 2008 Office Action and Beguinot. Based on my experience in metallurgy and with high strength alloy steels

in particular, it is my opinion that the materials described in Beguinot would not produce a low alloy carbon steel having the critical properties of Eglin Steel for the reasons stated below.

6. Using the actual chemical composition of heats ES-1 through ES-5 above, and the mechanical property data for the same heats in the Subject Application, I submit comparisons of the mechanical properties of the steel of Beguinot to that of Eglin Steel having compositions recited in the independent claims of the Subject Application. Slide A (attached) depicts the total percent elongation to failure, *i.e.*, a measure of the elongation after yielding and prior to breaking versus the ultimate tensile strength, or the strength at breaking. The percent elongation is a measure of the ductility of the steel. Slide B (attached) depicts the Charpy V-notch toughness versus the ultimate tensile strength of the steel. Charpy toughness is a measure of the toughness of the steel or the ability of the steel to absorb energy, such as from an impact. Slides A and B demonstrate that the steel of Beguinot exhibits either high strength or high ductility/toughness, whereas the Eglin Steel exhibits high strength, high ductility, and high toughness. The mechanical properties of Eglin Steel are clearly separated from those of the steel of Beguinot. The combination of properties for Eglin Steel is surprising and unexpected for a skilled practitioner since the strength of low alloy carbon steels is generally recognized to be inversely proportional to the ductility and toughness, as is exhibited by the steel of Beguinot.

7. Eglin Steel utilizes a low tempering temperature (400-500°F) in combination with high Si and W contents to produce a balance of ultra high strength of between 233-270 ksi and good toughness.

8. The microstructure of Eglin Steel consists of martensite and lower bainite with about 4-5% austenite.[1] The steel disclosed by Beguinot contains bainite and/or

[1] *See* attached, J. R. Paules, M. F. Dilmore, and K. J. Handerhan, "Development of Eglin Steel—A New, Ultrahigh-Strength Steel for Armament and Aerospace Applications," Proceedings Ferrous Metallurgy of Highly Alloyed Steels, Pittsburgh, PA, Sept. 25-28, 2005, Materials Science & Technology 2005. Note: while Figure 7 of the reference indicates 4-6% retained austenite, commercial Eglin Steel is austenized at 950°C, and as such has no more than about 5% retained austenite.

martensite and from 5-30%, preferably 10% to 20% of austenite having a high carbon content (See, Beguinot, column 4, lines 17-19).

9. In my opinion, the steel of Beguinot would have different mechanical properties from Eglin Steel because of the differences in actual chemistry, heat treatment, and microstructure. The microstructure of steel determines the final mechanical properties of the steel. A structure-property relationship exists. In my opinion, the higher level of austenite in the steel disclosed by Beguinot results in mechanical properties that are different from the mechanical properties of Eglin Steel, which exhibits a surprising combination of high strength and high toughness. The combination of high strength and high toughness is surprising because a skilled practitioner understands that generally there exists an inverse relationship between strength and toughness in low alloy carbon steels. Beguinot's higher retained austenite content, mixed with untempered martensite and/or bainite produces an inferior combination of strength and toughness when compared to Eglin Steel's microstructure of lightly tempered martensite combined with only about 4-5% retained austenite. When either tensile ductility or impact toughness is plotted vs. tensile strength, it is clear that Beguinot's steels do not match the combination of high strength and ductility and toughness that is achieved in Eglin Steel.

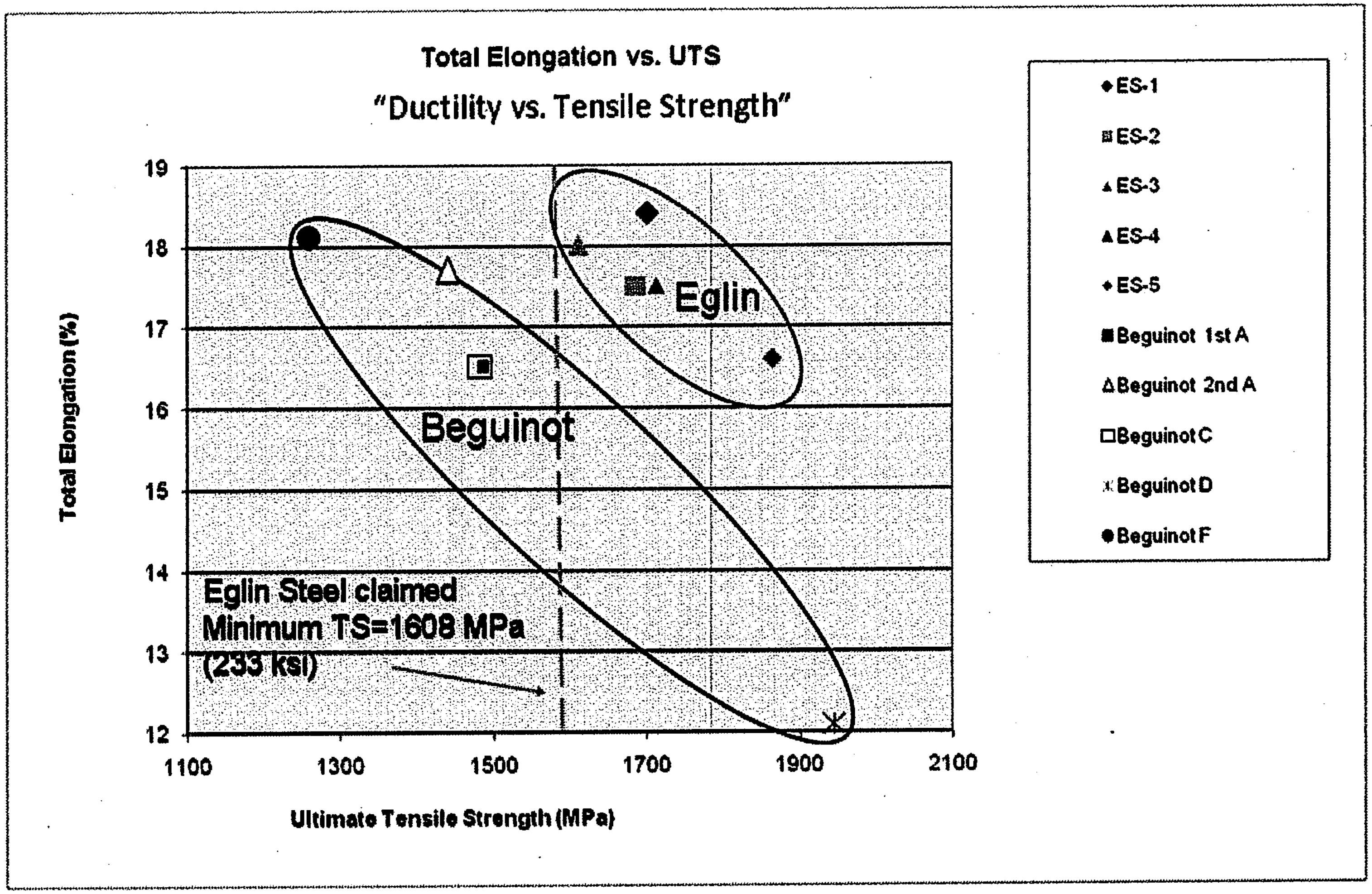
10. The claimed alloy of the Subject Application has a combination of high ultimate tensile strength and high toughness and ductility. These properties of Eglin Steel are critical for certain applications. The Charpy impact strength properties and the percent elongation of the steel disclosed by Beguinot are not as high as in Eglin Steel. The steel disclosed in Beguinot has either high strength or high ductility, compared with Eglin Steel, which has high strength and high ductility. Notwithstanding overlap in the ranges of some elements, the unique combination of elements in the amounts disclosed, and claimed in the Subject Application, together with the processing parameters, and in particular, the low temperature tempering step used with Eglin Steel produces a steel microstructure that results in a unique and unexpected combination of mechanical properties, which are critically different than those disclosed in Beguinot.

11. I further declare that all statements made herein are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any registration resulting therefrom.

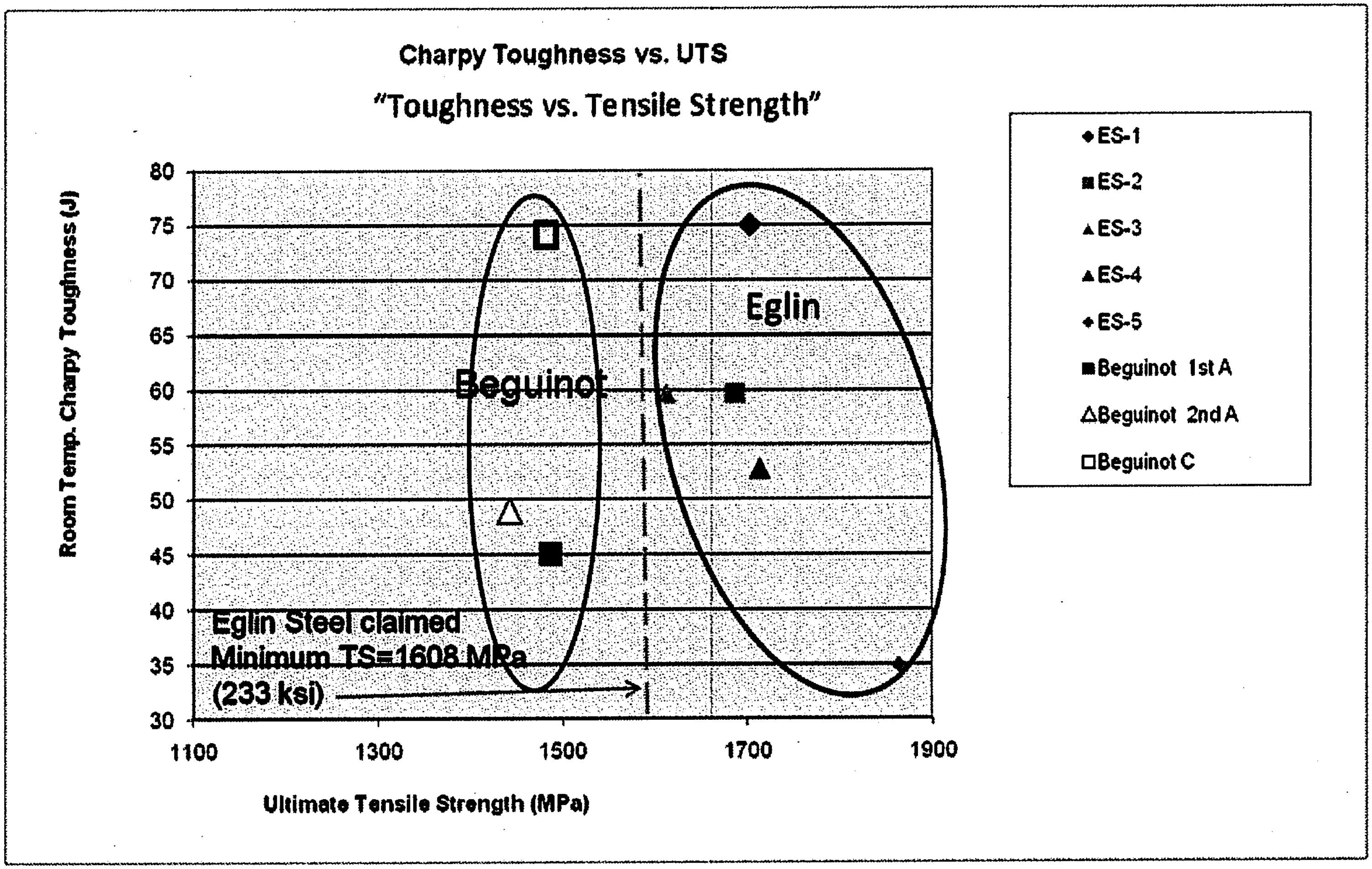
John R. Paules

12/19/08
Date

Slide A


Total Elongation vs. UTS
"Ductility vs. Tensile Strength"
Total Elongation (%)
19
18
17
16
15
14
13
12
1100
1300
1500
1700
1900
2100
Ultimate Tensile Strength (MPa)
Eglin
Beguinot
Eglin Steel claimed
Minimum TS=1608 MPa
(233 ksi)
ES-1
ES-2
ES-3
ES-4
ES-5
Beguinot 1st A
Beguinot 2nd A
Beguinot C
Beguinot D
Beguinot F

Slide B


Charpy Toughness vs. UTS
"Toughness vs. Tensile Strength"
Room Temp. Charpy Toughness (J)
80
75
70
65
60
55
50
45
40
35
30
1100
1300
1500
1700
1900
Ultimate Tensile Strength (MPa)
Beguinot
Eglin
Eglin Steel claimed
Minimum TS=1608 MPa
(233 ksi)
ES-1
ES-2
ES-3
ES-4
ES-5
Beguinot 1st A
Beguinot 2nd A
Beguinot C